REMARKS/ARGUMENTS

In an Office Action mailed April 27, 2006 (the "Office Action"), the Examiner:

A. Rejected claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0140407) in view of Cromwell (US Pat. 5,926,370); and

B. Rejected claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0140407) in view of Montgomery et al. (US Pat. Application Pub. 2003/0117770).

After entry of this amendment, the pending claims are: claims 1-21 and 28-32.

Applicant's Attorney thanks the Examiner for the telephone interview on June 6, 2006, in which the following remarks were discussed.

REMARKS

A. Rejection of claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0140407) in view of Cromwell (US Pat. 5,926,370)

Applicant respectfully requests that the Examiner reconsider this rejection for the following three reasons.

First, Dahl and Cromwell, either alone or in combination, do not make claim 28 obvious because they do not disclose a heat conductive media comprising copper that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate. In the Office Action at p. 6, the Examiner states:

> Cromwell is applied to Dahl et al. to provide the heat dissipation/heat sink structure comprising the heat pipes made of conventional copper material. . . . Cromwell is combined with the primary reference to provide the heat pipes made of copper.

The Applicant respectfully disagrees with the Examiner's analysis. Cromwell, either alone or in combination with Dahl, does not "provide the heat dissipation/heat sink structure comprising the heat pipes made of conventional copper material" in an integrated circuit die. Similarly, Cromwell, either alone or in combination with Dahl, does not "provide the heat pipes made of copper" in an integrated circuit die. Rather, Cromwell discloses conventional, macroscopic heat pipes "made of copper" that "contain water that undergoes a phase change when the evaporating end of the heat pipes is heated." (Cromwell, Col. 10, lines 22-24) Such

conventional, phase-change-cooled heat pipes are far too large to be incorporated in an integrated circuit die. In addition, "the 'suggested combination of references would require a substantial reconstruction and redesign of the elements shown in [the primary reference] [i.e., for Dahl to incorporate conventional, phase-change-cooled heat pipes] as well as a change in the basic principle under which the [primary reference] construction was designed to operate.'" [i.e., changing from solid-state heat conduction to phase-change cooling] See MPEP § 2143.01, citing *In re Ratti*, 270 F.2d 810, 813, 123 USPQ 349, 352 (CCPA 1959).

Second, a proper motivation to combine Dahl with Cromwell has not been provided. In the previous office action (mailed August 30, 2005), the following motivation to combine Dahl with Cromwell was given:

> It would have been obvious to a person of ordinary skill in the art at the time [the] invention was made to incorporate the HCM comprising copper as taught by Cromwell so that fabrication and processing can be simplified in Dahl et al's IC cooling structure. (emphasis added)

As noted in the Applicant's February 8, 2006 Amendment, Cromwell's conventional heat pipes are too large to be incorporated in an integrated circuit die. Thus, contrary to the previously stated motivation to combine Dahl with Cromwell, fabrication and processing would not be simplified by incorporating Cromwell's conventional heat pipes in Dahl et al's IC cooling structure.

In the present Office Action (mailed April 27, 2006), a new motivation to combine Dahl with Cromwell is given:

> It would have been obvious to a person of ordinary skill in the art at the time [the] invention was made to incorporate the HCM comprising copper as taught by Cromwell as an obvious alternative serving the purpose of heat management/dissipation in Dahl et al's IC cooling structure. (emphasis added)

It is respectfully submitted that a conclusory, hindsight-based 'It's obvious because its an obvious alternative' statement does not adequately address the issue of motivation to combine. As stated in *In re Sang Su Lee*, 277 F.3d 1338, 61 USPQ2d 1430 (Fed. Cir. 2002):

> The factual inquiry whether to combine references must be thorough and searching." [*McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 1351-52, 60 USPQ2d 1001, 1008 (Fed. Cir. 2001)] It must be based on objective evidence of record. This precedent has been reinforced in myriad decisions, and cannot be dispensed with. See, e.g., *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1124-25, 56 USPQ2d 1456, 1459 (Fed. Cir. 2000) ("a showing of a suggestion, teaching, or motivation to combine

the prior art references is an 'essential component of an obviousness holding'") (quoting *C.R. Bard, Inc., v. M3 Systems, Inc.*, 157 F.3d 1340, 1352, 48 USPQ2d 1225, 1232 (Fed. Cir. 1998)); *In re Dembiczak*, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999) ("Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references.")

Third, Dahl and/or Cromwell do not enable a person of ordinary skill to make and use the claimed invention. In the Office Action at p. 7, the Examiner states:

> Applicant contends that there is no teaching in Dahl et al. of how to make copper conduits, how to make copper conduits in fiber/rigid/flexible form, or how to insert from about 1 to 100 copper conduits into the chip; or how to communicate with thermal vias.
>
> However, as explained in the rejections above, Cromwell is combined with Dahl to provide the missing elements in Dahl et al's power/heat dissipation structure. Furthermore, the claims under examination are directed to the device and not a method of making such device. (emphasis added)

The Applicant respectfully disagrees with the Examiner's analysis, for the following reasons. As stated in *In re Kumar*: "to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention." (*In re Kumar*, 418 F.3d 1361, 1368 (Fed. Cir. 2005) emphasis added). This statement of law applies to claims directed to a device, not just to claims directed to a method of making the device. For claim 28, Dahl and/or Cromwell must enable a person of ordinary skill to make and use the claimed integrated circuit die.

This third reason is not concerned with 'missing elements.' Rather, this third reason is concerned with 'missing enablement.' Even assuming for the sake of argument that Dahl and Cromwell disclose a heat conductive media comprising copper that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate (an incorrect assumption), Dahl and/or Cromwell fail to enable one of skill in the art to make such a structure.

Dahl's discussion of heat conduits is contained in paragraph 0121, which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package. The heat conduits may be in fiber form, and may be inserted into the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits

may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in Dahl of: (1) how to make copper conduits in fiber form (either rigid or flexible); (2) how to insert from about 1 to 100 copper conduits into the chip; or (3) how to "communicate" with thermal vias (not shown).

Cromwell fails to provide the enablement that is missing in Dahl because Cromwell's teachings concern conventional, macroscopic heat pipes. Cromwell teaches nothing about how to make copper heat conduits in integrated circuit dies. Miniaturizing the conventional, macroscopic copper heat pipes of Cromwell to fit within an integrated circuit die is not taught by Cromwell or Dahl, and how to accomplish such miniaturizing would not be at all obvious from these references.

Thus, Dahl and/or Cromwell fail to enable one of skill in the art to make a heat conductive media comprising copper contained within at least one cavity extending from the backside surface of an integrated circuit substrate. Because Dahl and Cromwell fail to enable claim 28, Dahl and Cromwell also fail to make claim 28 obvious.

B. Rejection of claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0140407) in view of Montgomery et al. (US Pat. Application Pub. 2003/0117770)

Applicant respectfully requests that the Examiner reconsider this rejection for the following reasons.

First, Dahl and Montgomery, either alone or in combination, do not make claim 29 obvious because they do not disclose a heat conductive media comprising carbon nanotubes that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate. In the Office Action at p. 7, the Examiner states:

> Applicant contends that Montgomery et al. do not teach the carbon nanotubes within the IC die or making such structures within the IC die.
>
> However, the primary reference (Dahl et al.) discloses the IC die having [a] plurality of cavities/holes (see 633/634 in Fig. 6C), the cavities/holes being filled with heat conducting conduits/rods. Montgomery et al. combined with the primary reference to provide the heat conducting rods in the form of carbon nanotubes (see 26 in Fig. 4).

The Applicant respectfully disagrees with the Examiner's analysis. Dahl discloses that heat conduits (e.g., 631 and 632) made of diamondoid-containing materials may be inserted into the chip. Carbon nanotubes are not a diamondoid-containing material.

Montgomery et al. do not disclose carbon nanotubes contained in a cavity in an integrated circuit die. Rather, Montgomery et al. disclose thermal interface structures that make contact with the outer surface of an integrated circuit die, but are not located within an integrated circuit die.

Thus, Dahl and Montgomery, either alone or in combination, do not make claim 29 obvious because they do not disclose heat conductive media comprising carbon nanotubes that are contained within at least one cavity extending from the backside surface of an integrated circuit substrate.

Second, Dahl and/or Montgomery do not enable a person of ordinary skill to make and use the claimed invention. This reason parallels the third reason above concerning claim 28. As stated in *In re Kumar*: "to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention." (*In re Kumar*, 418 F.3d 1361, 1368 (Fed. Cir. 2005) emphasis added). This statement of law applies to claims directed to a device, not just to claims directed to a method of making the device. For claim 29, Dahl and/or Montgomery must enable a person of ordinary skill to make and use the claimed integrated circuit die.

This second reason is not concerned with 'missing elements.' Rather, this second reason is concerned with 'missing enablement.' Even assuming for the sake of argument that Dahl and Montgomery disclose a heat conductive media comprising carbon nanotubes that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate (an incorrect assumption), Dahl and/or Montgomery fail to enable one of skill in the art to make such a structure.

Dahl's discussion of heat conduits is contained in paragraph 0121, which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package. The heat conduits may be in fiber form, and may be inserted into the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in Dahl of: (1) how to make carbon nanotube conduits in fiber form (either rigid or flexible); (2) how to insert from about 1 to 100 carbon nanotube conduits into the chip; or (3) how to "communicate" with thermal vias (not shown).

Montgomery fails to provide the enablement that is missing in Dahl because Montgomery's teachings concern making carbon nanotube structures external to an integrated circuit die that make contact with the die (e.g., carbon nanotube bundles 26, which were previously grown on substrate 28, make contact with die 12 in Fig. 4). Montgomery teaches nothing about how to make carbon nanotube heat conduits in integrated circuit dies.

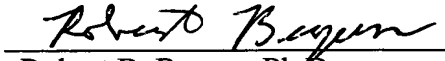
Thus, Dahl and/or Montgomery fail to enable one of skill in the art to make a heat conductive media comprising carbon nanotubes contained within at least one cavity extending from the backside surface of an integrated circuit substrate. Because Dahl and Montgomery fail to enable claim 29, Dahl and Montgomery also fail to make claim 29 obvious.

Because claim 29 is not made obvious by Dahl and Montgomery et al., dependent claims 30-32 are also not made obvious by Dahl and Montgomery et al.

In light of the above remarks, the Applicant respectfully requests that the Examiner reconsider this application with a view towards allowance. The Examiner is invited to call the undersigned attorney at 650-843-7528 if a telephone call could help resolve any remaining items.

Respectfully submitted,

Date: June 15, 2006



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